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ABSTRACT

A method is proposed for using computer systems to introduce students in geography courses on the college level to quantitative methods. Two computer systems are discussed--Interactive Computer Systems (computer packages which enhance student learning by providing instantaneous feedback) and Computer Enhancement of Instruction, CEI, (standard computer statistical packages which analyze data sets). Five steps are suggested for introducing students to quantitative research methods: (1) discuss the scientific method and geography as a science, (2) discuss a specific geography research problem, (3) discuss solving the problem using elementary statistics, (4) orient students to computer technology and arrange time for them at a computer terminal, and (5) discuss computer print out and help students design a research paper. Students participating in a program based on these steps are involved in drafting hypotheses, determining variables, collecting data, sampling, and analyzing data through computer methods. Examples are provided of statistical packages which are particularly effective with introductory students. The conclusion is that geography students will gain a better understanding and appreciation of geography if they learn to use quantitative methods to solve a geographical problem related to the geography course at hand. (DB)

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USING AN INTERACTIVE COMPUTER SYSTEM TO TEACH DESCRIPTIVE NUMERICAL ANALYSIS AND GEOGRAPHIC RESEARCH METHODS TO UNDERGRADUATE STUDENTS*

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USING AN INTERACTIVE COMPUTER SYSTEM TO TEACH DESCRIPTIVE NUMERICAL ANALYSIS AND GEOGRAPHIC RESEARCH METHODS TO UNDERGRADUATE STUDENTS

ABSTRACT

The question as to whether undergraduate geography students should be taught quantitative methods has long been answered. There is, however, concern as to when this should be done and how the introduction should take place. This paper proposes that undergraduate geography students be exposed to quantitative methods through interactive computer systems starting in their sophomore year. This exposure could also serve as an introduction to geographic research methods.

Most university computer systems have interactive software which contain interactive statistical packages. McGill University System for Interactive Computing (MUSIC), for example, has a statistical subroutine called STATPAK which painlessly introduces undergraduates (as well as their instructors) to the computer and basic numerical analysis. Of the many analyses available in STATPAK, this paper will focus upon elementary statistics, scatter diagrams, correlations, t-test and histograms within the context of a specific geographic research problem.

I. INTRODUCTION

There is no doubt that the computer age has penetrated all aspects of our society. Business, as well as, local, state, and national government agencies rely heavily upon computerized data analysis, modeling, and record keeping. For geography students to successfully function and compete within our society, it is necessary for them to become familiar with, and be able to use the computer.

Traditionally, undergraduate computer usage has emphasized computer assisted instruction (CAI) (1, 3, 6, 7, 8, 10). While most of these programs provide a useful initiation to the computer, they are limited to the problem at hand, and except with major program revision, are not easily applied to other problems. Furthermore, many of the CAI's have

to be purchased and operationized, which may be beyond the scope of the geography instructor or department.

Another use of the computer as an instructional tool focuses upon computer enhancement of instruction (CEI). Primarily used for technique courses and by graduate students, CEI, uses standard computer statistical packages to analyze data sets (3). An advantage of CEI lies in the fact that almost all university computer systems have some type of statistical package which could be suitable for almost any geographical problem and data set. Furthermore, many university computer systems even have interactive statistical packages which are very easy to use and enhance a student's learning experience through instantaneous feedback.

This paper proposes that undergraduate geography students be introduced to interactive statistical packages, available on most computer systems, as a means of quantitatively solving geographic research problems.

II. STEPS FOR A SUCCESSFUL INTRODUCTION TO CEI

Given a plausible research problem, hypotheses, and a data set, undergraduate students can be introduced to interactive computers and geographical problem solving quite easily. This exposure to computerized data analysis can be started at the sophomore level provided that certain precautionary steps are followed,

TABLE ONE: STEPS FOR A SUCCESSFUL INTRODUCTION TO GEOGRAPHIC RESEARCH METHODS, BASIC NUMERICAL ANALYSIS, AND THE COMPUTER

A. Discuss Geography as a Science and the Scientific Method

B. Discuss a Specific Geography Research Problem:

Observation

Hypothesis

Sampling

Data Collection

Data Analysis

Conclusions

C. Discuss Solving the Problem with Basic Numerical Statistics Available in STATPAK:

Histogram

Elementary Statistics

Scatter Diagram

Correlation Coefficient

T-Test

D. Computer Orientation:

Orientation Lecture about Computers and Accessing STATPAK

Relate STATPAK Procedures to Research Problem

"Hands On" Experience With Computer Terminal Under Faculty or Graduate Student Supervision

E. Completion of a Research Paper:

Discussion of Proper Design for a Research Paper

Discussion of Computer Printout

III. AN EXAMPLE OF A GEOGRAPHIC RESEARCH PROBLEM

Observation

After the student has been exposed to geography as a science and the scientific method, which could easily be done in the freshman level introductory courses, class discussion should focus upon a specific geographical problem that relates to the course at hand (9). The problem used in this paper as an example concerns spatial inequality in the United States, which is exhibited in the spatial variation of several socio-economic variables.

Hypothesis

Class discussion with prompting from a list of variables should enable students to develop several hypotheses regarding the problem of spatial inequality. Five such variables chosen for this sample study were: 1) median family income, 2) median value of owner occupied housing, 3) percent of all families with incomes less than poverty level, 4) percent of the total population that is non-white, and 5) median school years completed by persons 25 years and over.

Several hypotheses that can be tested using these socio-economic variables are:

1) Median family income is directly related to median school years.
2) Median family housing value is directly related to median family income.
3) Median family income is indirectly related to percent of the total population that is non-white.
4) The number of families below the poverty level is indirectly related to median school years.

While these are by no means the only hypotheses that could be tested, it is important not to overwhelm the students with too many relationships to examine.

Sampling and Data Collection

Once the desired number of hypotheses are stated, a discussion of sampling and data collection could ensue. This is a good opportunity to expose students to different types of data sources such as the U. S. Census.

Data Analysis

Discussion as to how the hypotheses are going to be quantitatively examined should center around statistical methods that the students are familiar with. Most students have been exposed to the arithmetic mean, the range, and the standard deviation, if only through their exam scores. In addition, many introductory textbooks are using scatter diagrams to show relationships between variables, and some even talk about the correlation coefficient (9). This discussion should remind students that many geographical problems must be solved quantitatively and hence the need for geographers to be acquainted with statistical methods.

Computer Applications

Many of these data analyses can be done using the computer in either batch mode or interactive mode. The interactive computer method is, perhaps, the best means of analysis as it allows the student to directly relate to the computer. This interaction gives the student a better understanding of what is going on, and also gives her/him a sense of control and accomplishment.

IV. INTERACTIVE COMPUTERS AND INTERACTIVE STATISTICAL PACKAGES

MUSIC, McGill University System for Interactive Computers, is an interactive computer system which is a terminal-oriented time-sharing system (12). As with all time-sharing systems, many users may have access to the computer at the same time and receive (almost) instantaneous results. The relative ease of operation and rapid results, make MUSIC an ideal tool for introducing undergraduate geography students to the magical world of computers and data analysis.

MUSIC is a very versatile system which allows users to program in six different languages and have access to several statistical packages. One such package is called STATPAK which has over 23 statistical analyses and data modification routines (11),

TABLE TWO STATPAK ROUTINES

Edit	Step-wise regression
Transformation	Multiple regression
Elementary statistics	Polynomial regression
Correlation (product moment)	One-way analysis of variance
Cross tabulation	Analysis of variance
Scatter diagram	Canonical correlation
Histogram	Factor Analysis
Line plot	Discriminant analysis
Rank correlation (Kendall's)	Simple exponential smoothing
Chi-square	Exponential smoothing (triple)
T-test	Probit analysis
Regression	

Before a user can access STATPAK he/she must get a user identification code and a password which are issued by the computer center. After the user has gotten on to the system, the user must have a data set already stored in the computer or be prepared to input a data set at the begining of the STATPAK routine. Table Three shows an example of the commands needed to access STATPAK:

TABLE THREE: ACCESSING STATPAK

```
/input
/include statpak
/include usame
/endrun
```

USAME is the code name of a data set which will be used to illustrate several basic numerical analyses.

Once the user is into the STATPAK routine, she/he will be asked several basic questions,

TABLE FOUR: BASIC STATPAK QUESTIONS

Do you wish to list names of available analyses?

What analysis do you wish to perform?

How many columns in your data matrix?

How many rows in your data matrix?

Specify input code for your data.

Do you wish to print the data just read in?

Do you wish to change some values?

The answers to these questions are either yes, no, or some number. If a user does not understand a question, she/he should type SOS and a detailed explanation of the question will be printed out.

As with most computer software packages, a detailed book is available which lists all the questions that will be asked as well as sample answers (11). This book is usually available at or through a university computer center.

V. GEOGRAPHICAL DATA MATRIX

The data to be analyzed by STATPAK must be put in the form of a matrix, with attributes for a single observation on one line. There is a size limitation of 600 rows and 15 columns, with a maximum of 1200 elements. The data can be put in a free format or fixed format, and can be called from disk or be put in at the terminal during the analysis. The format of the data input mode presents the undergraduate geography student with the opportunity of being introduced to the concept of a geographical data matrix (2).

The sample data set, USAME, consists of five attributes for each state, thus the geographical matrix has 50 rows, 5 columns, and is only concerned with one time period.

Before discussing what to do with the data, the students must understand why she/he is using that particular data set. Given the context of a geographical research problem, the application of basic numerical analysis can be viewed as a means to an end and not just an end unto itself.

VI. BASIC NUMERICAL ANALYSES

There are four routines in STATPAK that can be used with minimal statistical background: elementary statistics, histogram, scatter diagram, and correlation.

Elementary Statistics

This routine gives a very basic description of the data set,

TABLE FIVE: ELEMENTARY STATISTICS FOR SAMPLE DATA SET, USAME

VARIABLE	MEAN	STD.DEV.	STD.ERROR	MAXIMUM	MINIMUM	RANGE
1	9169.459	1473.543	208.319	12443.000	6071.000	6372.000
2	16281.000	4600.332	650.585	35100.000	10500.000	24600.000
3	11.614	5.208	0.737	28.900	5.300	23.600
4	11.646	11.337	1.603	61.200	0.400	60.800
5	11.838	0.682	0.096	12.500	9.900	2.600

The items listed are the barest amount of information one needs to know about a numerical distribution. You will also notice that there is no labeling for the variables, simplifying the analysis of the data.

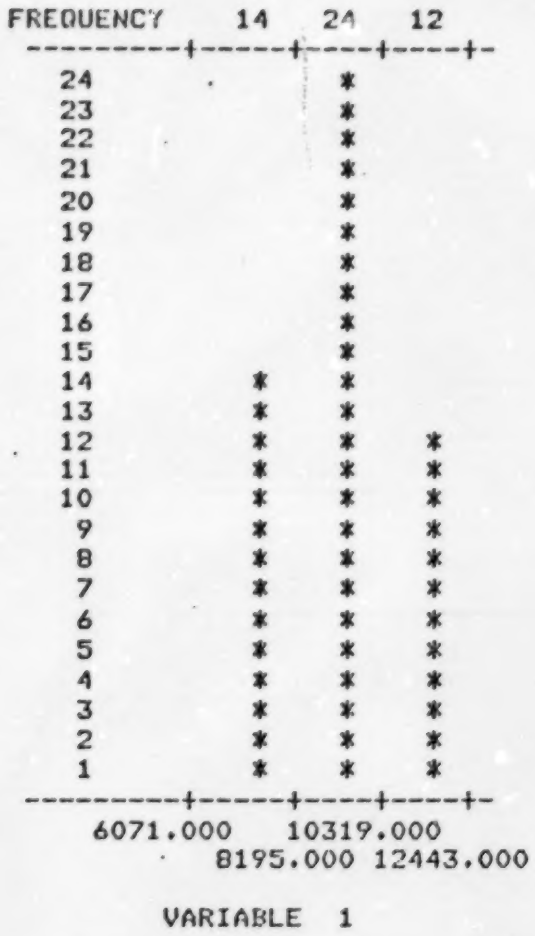
Histogram

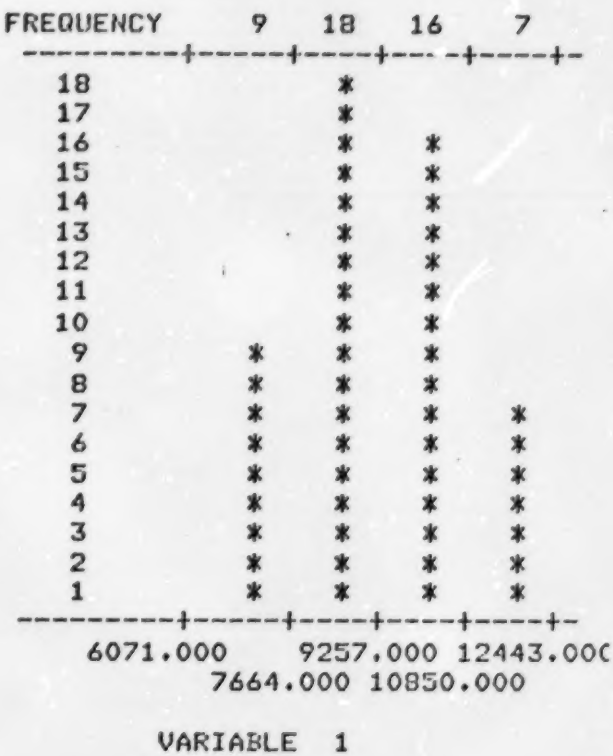
The histogram routine gives the student a visual representation of the numerical distribution. Variable one, median family income is shown in Figure One, a,b,c,. The program allows up to 10 equal intervals to be calculated for each variable. Starting with a few intervals, a student could progress up to 10 intervals and see whether the additional intervals have added to the understanding of the numerical distribution. This procedure could also help students ascertain what class interval labels to use when constructing a map of a variable.

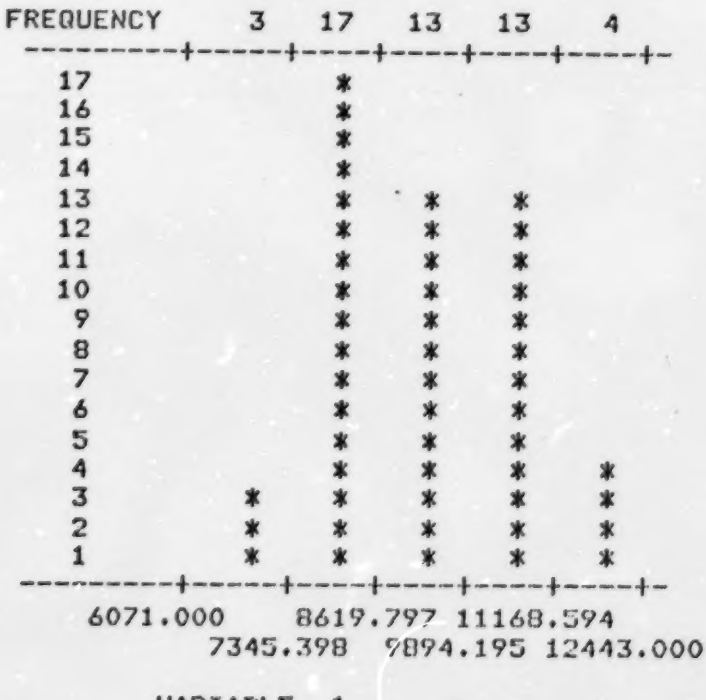
Scatter Diagram

The scatter diagram routine allows two variables to be related to one another with the user specifying the dependent and independent variables, Figure Two.

Figure One: Examples of Histograms







Given the direction of the data points a student could qualitatively decide whether the relationship was an indirect or a direct relationship.

Correlation

After the user has visually examined a relationship using a scatter diagram, she/he can proceed to a quantitative examination. The correlation routine uses Pearson's product moment correlation and prints out a complete correlation matrix, Table Six. If a non-parametric correlation is desired, then Rank Correlation (Kendall's) could be used.

TABLE SIX: CORRELATION MATRIX FOR SAMPLE DATA SET

ROW 1				
1.000	0.836	-0.853	-0.072	0.668
ROW 2				
0.836	1.000	-0.600	0.294	0.459
ROW 3				
-0.853	-0.600	1.000	0.436	-0.812
ROW 4				
-0.072	0.294	0.436	1.000	-0.397
ROW 5				
0.668	0.459	-0.812	-0.397	1.000

T-Test

If the students are familiar with tests of significance it would be advisable to have them carry out a t-test for each correlation. The STATPAK analysis calculates the computed T value and the degrees of freedom. A student could then use a "t" table to ascertain the significance of each relationship.

VII. COMPUTER ORIENTATION

Before these analyses are attempted it is very important to give a non-technical lecture about the computer emphasizing the need to follow instructions to the letter. Discussion should focus upon the questions STATPAK (or whatever statistical package you are using) will ask about the data set and the analyses to be performed. This introductory lecture should lessen many of the problems that arise when becoming acquainted with the computer and the interactive statistical package.

The final phase of the computer orientation is a 'hands on' demonstration of the interactive program under the direct supervision of the instructor and/or graduate assistant. It is best to have the students analyze a previously stored data set so that they may become familiar with the computer's procedures and the interactive statistical package. If you feel that your students are familiar enough with the computer you might have them store their own data on disk. It is highly recommended that you try not to do too much during the students' initial orientation to the computer. When the students feel comfortable about using the computer and the interactive program, you can have them collect, and store data which is relevant to a particular problem.

It is highly recommended that the instructor and/or graduate assistant be handy to answer any questions that might arise during the initial contact with the computer. Many students have been put into a 'sink or swim' situation and unfortunately may have 'drowned' and have avoided the use of computers ever since.

These precautions are without a doubt primary factors in overcoming the fear of computers and are a very essential part of computer orientation. It may also be noted that these procedures take a great deal of the instructor's time and energy. This, however, will diminish as the

students are continuously using computers and statistical analysis throughout their geography program.

VIII. COMPLETION OF A RESEARCH REPORT

Once the students have performed the data analyses it is important to go over the computer printout and discuss the results. Were the hypotheses substantiated by the scatter diagrams, correlation coefficients and t-tests? What do the spatial patterns of each of the variables tell us?

After a discussion of the computer printout, students should be shown how to translate the printout into a well organized and coherent research paper. It is important to have students begin to learn how to verbalize their research findings as soon as possible.

IX. CONCLUSIONS

Undergraduate geography students must become acquainted with both quantitative methods and the computer. Put in the context of a geographical problem that relates to the geography course at hand, students can gain a better understanding and appreciation of computers, statistical methods, and the field of geography as a science.

Students must be shown the need to use statistical methods and the computer. These goals can be accomplished by having them solve simple problems, not only in their methods courses, but in all of the upper level courses. Once the need is demonstrated, the desire to use statistical methods and the computer will follow.

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